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Roman L. Hruska U.S. Meat Animal Research Center
in Cooperation with Kansas State University and
University of Nebraska Institute of Agriculture and
Natural Resources, Nebraska Agricultural
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The cattle Germ Plasm Evaluation Program at the Roman L. Hruska U.S. Meat Animal Research Center is designed to characterize different biological types represented by breeds varying widely in characteristics such as milk production, growth, mature size, and carcass composition. A major objective is to characterize breeds representing different biological types in different feed environments and production situations for the full spectrum of biological traits relating to economic beef production.

A coordinated research effort is employed involving scientists from the disciplines of animal breeding, reproductive physiology, nutrition, meats, and production systems. The program was initiated in 1969. Progress reports have been published annually summarizing current results from each cycle and phase of the program for traits of principal economic importance to the beef cattle industry.

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ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER

25 CATTLE GERM PLASM EVALUATION PROGRAM

2 PROGRESS REPORT NO. 11 N

Larry V. Cundiff, Keith E. Gregory and Robert M. Koch

INTRODUCTION

A vast array of both resources and cattle breeds are available for beef production in the United States. Although feeding concentrates has provided for a relatively high degree of uniformity in the growing-finishing segment of beef production, resources used for cow-calf production have remained and will continue to remain very diverse. In the United States, stocking rates range from one cow per 2 acres or less to only one cow per 300 or 400 acres because of differences in climate, land, and feed resources.

The germ plasm base for beef cattle production in North America was broadened considerably during the 1970's, primarily, as a result of the introduction of new breeds of European origin made possible by the development of appropriate quarantine facilities and procedures by Agriculture Canada. The newly introduced breeds, in addition to those already available, provide a wide range of performance characteristics in beef cattle.

In 1969, the Roman L. Hruska U.S. Meat Animal Research Center implemented a program to characterize a broad range of biological types of cattle as represented by breeds that differ widely in characteristics such as growth rate, carcass composition, mature size and milk production level. The primary objective was to characterize breeds representing diverse biological types for the full spectrum of traits relating to beef production. The breeds used in this program have been classified into six different biological types based on the criteria of (1) growth rate and mature size, (2) lean to fat ratio, (3) age at puberty and (4) milk production (table 1).

The intent of this program was to collaborate with research organizations at other locations so that characterizations would be done in different climatic and feed environments to gain information needed for "matching" biological types with production resources for optimum conversion rate. Collaborative efforts involving a sample of biological types have been implemented with Agriculture Canada; the Beef Cattle Research Station at Brooksville, Florida, involving both the USDA and the Florida Agricultural Experiment Station; the Louisiana Agricultural Experiment Station at Baton Rouge; and the Livestock and Range Research Station at Miles City, Montana, involving the USDA and the Montana Agricultural Experiment Station. Simmental, Maine-Anjou, Chianina, and Brahman crosses with Hereford and Angus dams were produced by the Louisiana Agricultural Experiment Station; Angus-Hereford crosses, Pinzgauer, Sahiwal, and Brahman crosses with Hereford and Angus dams are included in the program at Brooksville; and Angus, Simmental, Red Poll, and Pinzgauer crosses with Hereford dams were produced at Miles City, Montana. Comparative results are not yet available from these locations.

TABLE 1. BREED CROSSES GROUPED IN BIOLOGICAL TYPE ON BASIS OF FOUR MAJOR CRITERIA^a

Breed group	Growth rate & mature size	Lean to fat ratio	Age at puberty	Milk production
Jersey-X	X	X	X	XXXXX
Hereford-Angus-X	XX	XX	XXX	XX
Red Poll-X	XX	XX	XX	XXX
Devon	XX	XX	XXX	XX
South Devon-X	XXX	XXX	XX	XXX
Tarentaise-X	XXX	XXX	XX	XXX
Pinzgauer-X	XXX	XXX	XX	XXX
Brangus-X	XXX	XX	XXXX	XX
Santa Gertrudis-X	XXX	XX	XXXX	XX
Sahiwal-X	XX	XXX	XXXXX	XXX
Brahman-X	XXXX	XXX	XXXXX	XXX
Holstein	XXXX	XXX	XX	XXXXXX
Brown Swiss-X	XXXX	XXXX	XX	XXXX
Gelbvieh-X	XXXX	XXXX	XX	XXXX
Simmental-X	XXXXX	XXXX	XXX	XXXX
Maine Anjou-X	XXXXX	XXXX	XXX	XXX
Limousin-X	XXX	XXXXX	XXXX	X
Charolais-X	XXXXX	XXXXX	XXXX	X
Chianina-X	XXXXX	XXXXX	XXXX	X

^a The number of "X's" indicates increasing relative differences among breed groups for (1) growth rates and mature size, (2) lean to fat ratio, (3) age at puberty and (4) milk production found in the Germ Plasm Evaluation Program at the Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, Nebraska.

Previous progress reports have presented complete data on birth, survival, and preweaning growth of steers and heifers; postweaning growth and puberty of females; postweaning growth and feed efficiency of steers; and carcass and meat characteristics of steers produced in the program¹. This report provides an up-to-date summary of reproduction and maternal performance data for cows in each cycle of the Germ Plasm Evaluation Program.

PROCEDURE

The cattle Germ Plasm Evaluation Program has been conducted in a series of three cycles (referring to different sets of sire breeds) and phases (referring to different sets of cows). Foundation cows (Hereford and Angus, in Cycles I, II, and III, plus Red Poll and Brown Swiss in Cycle II) are referred to as Phase 1. Their progeny are referred to as Phase 2, and progeny from Phase 2 are designated as Phase 3. Specific mating plans for each cycle and phase of the program are provided in the appendix.

Mating Plans and Management

Cycle I-Phase 2. The foundation Hereford and Angus cows used in the program were purchased as calves at weaning from commercial producers in Nebraska. The cows were 2 through 5, 2 through 6 and 3 through 7 years old at calving in the spring (mid-March through April) in 1970, 1971, and 1972, respectively. The Hereford and Angus cows were bred by artificial insemination (AI) to 32 Hereford, 35 Angus, 33 Jersey, 28 South Devon, 20 Limousin, 28 Simmental, and 26 Charolais bulls to produce the Cycle I-Phase 2 calves. The Hereford and Angus bulls used in this program were sampled from bulls that had been selected on individual performance information, which was the basis for entering into the progeny testing programs of commercial AI organizations. The Jersey bulls were selected at random from two commercial AI organizations, and the South Devon bulls were sampled from an importation made in 1969 by a commercial organization. Simmental, Limousin, and Charolais bulls were sampled from bulls available from commercial AI organizations and from the Research Branch, Agricultural Canada for the Simmental and Limousin.

Cycle I-Phase 2, yearling heifers were mated to Hereford, Angus, Brahman, Devon, and Holstein bulls during a 45- to 46-day AI season and to Hereford and Angus bulls for a 21- to 24-day clean up period in 1971, 1972, and 1973 (appendix table 3). As 2-year-old cows, they were mated to Hereford, Angus, Chianina, Gelbvieh and Maine Anjou bulls for a 42- to 45-day AI season and to Hereford and Angus bulls during a 22-day cleanup in 1972, 1973, and 1974. As 3-year-olds and at subsequent ages through 8 years of age, the cows were mated by natural service to Brown Swiss (predominantly European) bulls. Progeny out of Cycle I-Phase 2 cows were born in the spring, reared without creep feed and weaned in the fall of each year (1972-80) at about 200 days of age.

Cycle I-Phase 3. The mating plans to produce Cycle I-Phase 3 calves are shown in appendix table 3. These calves were out of Cycle I-Phase 2 females

¹ See Beef Research Progress Report No. 1, U.S. Department of Agriculture, Agricultural Research Service, Roman L. Hruska U.S. Meat Animal Research Center. ARM-NC-21, April 1982.

bred AI as yearling heifers to 16 Hereford, 25 Angus, 14 Brahman, 12 Devon, and 13 Holstein sires for 45 to 46 days followed by a 21- to 24-day clean up natural service mating period to Hereford and Angus sires. The three-way cross females resulting from these matings were retained to evaluate their reproduction and maternal performance when mated naturally to Red Poll bulls. The Red Poll sired progeny were born in the spring of 1974, 1975, 1976 and 1977. The progeny were raised by their three-way cross dams without creep feed until weaning in October of each year at about 200 days of age.

Cycle II-Phase 2. The mating plans to produce Cycle II-Phase 2 calves are shown in appendix table 2. The Cycle II-Phase 2 progeny resulted from AI matings to 15 Hereford, 16 Angus, 16 Red Poll, 11 Brown Swiss (7 European, 4 domestic), 11 Gelbvieh, 18 Maine Anjou, and 20 Chianina sires. The Hereford and Angus sires had also been used in Cycle I of the program, and the other bulls were sampled from commercial organizations. The foundation Hereford and Angus dams used in Cycle I were continued in Cycle II. Thus, the Cycle II-Phase 2 progeny produced in 1973 were out of 4- to 8-year-old cows and those produced in 1974 were out of 4- to 9-year-old cows. As indicated in appendix table 2, mature Brown Swiss and Red Poll cows were added to the foundation herd to produce 4x4 diallel progeny involving Herefords, Angus, Red Poll and Brown Swiss breeds in 1973 and 1974; results involving progeny out of Red Poll and Brown Swiss dams are not included in this present summary.

Cycle II-Phase 2, yearling heifers were mated to Hereford, Angus, Brangus and Santa Gertrudis sires used by AI to produce 2 calf crops (Cycle II-Phase 3 progeny) in the spring of 1975 and 1976 (see appendix table 4). As 2-year-olds and at subsequent ages through 7 years of age, the cows were mated by natural service to 3/4 or 7/8 Simmental bulls. Progeny out of Cycle II-Phase 2 cows were born in the spring, reared without creep feed and weaned in the fall of each year (1975-82) at about 200 days of age.

Cycle II-Phase 3. The mating plans to produce Cycle II-Phase 3 calves are shown in appendix table 4. The Cycle II-Phase 3 females were out of Cycle II-Phase 2 females bred AI as yearlings to 13 Hereford, 14 Angus, 14 Brangus and 13 Santa Gertrudis sires. Females resulting from cleanup natural service matings to Hereford and Angus sires were also included in the study. The three-way cross females resulting from these matings were retained to evaluate their reproduction and maternal performance when mated naturally to Shorthorn bulls. The Shorthorn-sired progeny were born in the spring of 1977, 1978, 1979 and 1980. The progeny were raised by their three-way cross dams without creep feed until weaned in October of each year at about 200 days of age.

Cycle III-Phase 2. The mating plans to produce Cycle III-Phase 2 calves are shown in appendix table 5. The Cycle III-Phase 2 progeny resulted from AI matings to 13 Hereford, 14 Angus, 17 Brahman, 6 Sahiwal, 9 Pinzgauer and 7 Tarentaise sires. The Hereford and Angus sires had been used AI in all previous cycles and phases of the program. The Brahman bulls were sampled from commercial AI organizations or purebred Brahman herds. Semen was available from commercial sources for the Sahiwal (semen originally imported

from Australia), Tarentaise and Pinzgauer bulls sampled. The foundation Hereford and Angus cows used to produce Cycle III-Phase 2 progeny included females that had been used to produce Cycle I-Phase 2 and Cycle III-Phase 2 progeny supplemented by additional Hereford and Angus sampled from the same general area (foundation Hereford and Angus females were purchased as calves from commercial producers in western Nebraska). The Cycle III-Phase 2 progeny were produced in 1975 and 1976 out of dams ranging from 4 to 11 years of age.

Cycle III-Phase 2 yearling heifers were mated by natural service to Red Poll bulls to produce their first calf crop as 2-year-olds and to 7/8 or purebred Simmental bulls to produce their second through sixth calf crop at 3 through 7 years of age. The progeny were born in the spring, reared without creep feed and weaned at about 200 days of age in October of each year from 1977 through 1982.

Traits measured

Calving difficulty. Calving difficulty scores were assigned to each calf at birth. For this report, calves born with no assistance or hand assistance were classified as not difficult and calves requiring assistance with calf puller or delivered by caesarian section were classified as difficult (0 = no difficulty, 1 = difficult).

Calf crop. Calf crop percentages reflect the percentage of cows giving birth to or weaning a calf relative to all cows alive at calving time (0 = no calf, 1 = calf). Since cows were removed from the experiment only for serious injury, or for being open 2 successive years or for death, percentage calf crop relative to all cows calving is virtually the same as percentage calf crop relative to all cows exposed to breeding.

Calf weights. Calf birth weights reported are adjusted to a steer basis by adjustment factors calculated directly from the least squares analyses of the data. The 200-day weight per calf weaned was computed as ((actual weaning weight - birth weight)/weaning age) x 200 + birth weight. The 200-day weight per cow exposed was computed as (200-day weight) x (calf crop percentage) x (0.01).

Milk production. Cows and calves were separated for 12 hours, after which calves were weighed, allowed to nurse their dams, and reweighed. The change in calf weight was used to estimate 12-hour milk productions. This procedure was used to estimate milk production at three different times during lactation (about 130, 160 and 190 days postpartum) on a sample of the Cycle I-Phase 2, Cycle II-Phase 2 and Cycle III-Phase 2 of the program (see footnotes in tables 2, 4 and 6).

Cow weights. Cow weights and hip heights reported were obtained in the fall at weaning time.

Analyses

All data were analyzed by least squares procedures using models that included fixed effects for breed groups, cow age-year, sex of calf (calving difficulty and calf weights only), and most two-factor interactions.

RESULTS

Cycle I-Phase 2. Results on production of the F₁ females (as 2-through 8-year-olds) are summarized for Cycle I, Phase 2 females in table 2. Results presented in table 2 are adjusted for differences in sire breed of calf, for age of dam, and year, and to a steer basis. Jersey cross females experienced less calving difficulty than other breed groups in Cycle I, especially as 2-year-olds (see table 1, in Progress Report No. 1). Differences in calving difficulty of F₁ cows were associated with birth weight of their calves. The relatively heavy weaning weights of calves from Simmental and Jersey cross dams in Cycle I reflect their greater milk production. Jersey cross dams produced more milk, but calves with Simmental and Charolais cross dams were heavier at weaning than calves with Jersey cross dams because of greater growth rate transmitted by Simmental and Charolais cross dams. Calf weight at 200 days per F₁ cow exposed to breeding among the breed groups included in Cycle I had a range of 8% (i.e., 100% for Limousin and Hereford-Angus crosses to 108% for Simmental crosses).

Cycle I-Phase 3. Results on production of the 3-way cross females (as 2-through 5-year-olds) from Cycle I, Phase 3 of the program are summarized in table 3. Calving difficulty was less in Brahman cross and Devon cross females than Hereford-Angus cross and Holstein cross females. Calves out of Brahman cross females were significantly lighter at birth than calves out of all other crosses. Calves out of Holstein cross females were significantly heavier at birth than calves out of Hereford-Angus cross and Devon cross females; however, Holstein crosses did not differ significantly from Hereford-Angus crosses in calving difficulty. Differences between breed groups for percentage calf crop born and percentage calf crop weaned were not significant ($P>.05$). Weaning weight per calf weaned and per cow exposed to breeding was significantly higher for progeny of Holstein cross and Brahman cross females than for progeny of Hereford-Angus cross and Devon cross females.

Cycle II-Phase 2. Results on production of the F₁ females as 2- through 7-year-olds from Cycle II, Phase 2 of the program are presented in table 4. Calving difficulty has been lower for Brown Swiss and Chianina cross females than other breed groups, especially as 2-year-olds (table 13, Progress Report No. 9). Chianina cross females have had relatively low calving difficulty considering the heavy birth weight of their calves. Brown Swiss cross and Gelbvieh cross females milked at the highest level and produced calves that were 12% heavier at 200 days than Hereford-Angus cross females. Maine Anjou cross and Chianina cross females were comparable with Hereford-Angus crosses in milk production but produced calves that were 10% heavier in 200-day weight. Red Poll cross females were intermediate in the range among breed groups for milk production and 200-day weight of progeny. Calf weight weaned per cow exposed was 12% to 16% greater for Brown Swiss, Gelbvieh, Maine-Anjou, and Chianina crosses than for Red Poll and Hereford-Angus crosses.

Cycle II-Phase 3. Results on production of the 3-way cross females (as 2-through 5-year-olds) from Cycle II, Phase 3 of the program are summarized in table 5. Calving difficulty was less in Santa Gertrudis crosses than in Brangus and Hereford-Angus crosses because of less calving difficulty

as 2-year-olds (see table 18 in Progress Report No. 9). Calves out of Brangus and Santa Gertrudis crosses were 5% and 6%, heavier, respectively, at 200 days than calves out of Hereford-Angus crosses.

Cycle III-Phase 2. Results on production of the F₁ females (as 2- through 7-year-olds) from Cycle III, Phase 2 of the program are summarized in table 6. Sahiwal and Brahman cross females experienced significantly less calving difficulty than the other breed groups in Cycle III. This difference in calving difficulty in favor of Sahiwal and Brahman crosses was of greatest magnitude for the first parturition as 2-year-olds (table 23, Progress Report No. 9). Birth weight of calves out of Pinzgauer and Tarentaise crosses have been heavier than calves out of Hereford-Angus crosses while birth weight of calves out of Sahiwal and Brahman crosses have been lighter than Hereford-Angus crosses. Differences in milk production between Tarentaise, Pinzgauer, Sahiwal, and Brahman cross females were not large; all exceeded Hereford-Angus cross females. Brahman crosses exceeded all crosses in 200-day weight weaned per calf and per cow exposed to breeding. Weaning weights of progeny out of Pinzgauer, Tarentaise, and Sahiwal cross females were 6% to 10% heavier per calf weaned and 8% to 12% heavier per cow exposed to breeding than progeny out of Hereford-Angus cross females.

TABLE 2. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
BREED GROUP MEANS FOR REPRODUCTION AND MATERNAL PERFORMANCE OF F₁ COWS AT 2 THROUGH 8 YEARS OF AGE
CYCLE I-PHASE 2 - COWS BORN 1970-71-72a

Breed of cow			Number births	Calving diffi- culty ^b			Birth weight ^c lb	Milk prodd lb	Cow weight ^e lb	200-day weight		Ratio ^f %
Sire	Dam	Born		Calf crop Weaned	Per calf weaned ^c lb	Ratio ^f %				Per cow exposed lb		
Angus Hereford	Hereford	360	9	93	84	86		1219	480	102	403	101
	Angus	378	12	93	86	87		1231	465	99	400	100
	Average	738	10	93	85	86	6.6	1225	472	100	401	100
Jersey	Hereford	346	3	94	89	81		1071	495	105	441	110
	Angus	282	5	89	81	77		1067	486	103	394	98
	Average	628	4	92	85	79	9.7	1069	490	104	417	104
South Devon	Hereford	319	13	90	86	93		1277	490	104	421	105
	Angus	284	11	90	85	89		1254	489	104	416	104
	Average	603	12	90	86	91	7.0	1266	489	104	421	105
Limousin	Hereford	425	8	89	81	89		1240	485	103	393	98
	Angus	426	10	93	85	86		1230	479	101	407	102
	Average	851	9	91	83	88	6.0	1235	481	102	399	100
Simmental	Hereford	488	16	92	87	93		1273	520	110	452	113
	Angus	384	13	90	82	90		1291	516	109	423	105
	Average	872	14	91	84	91	8.8	1282	518	110	435	108
Charolais	Hereford	412	12	92	83	93		1367	500	106	415	103
	Angus	281	12	89	80	92		1347	500	106	400	100
	Average	693	12	90	81	93	6.0	1357	500	106	405	101
Average all sire breeds	Hereford	2350	10	92	85	89		1241	495	105	421	105
	Angus	2035	10	91	83	87		1237	489	104	406	101
	Average	4385	10	91	84	88	7.4	1239	492	104	413	103

- a These cows were bred to Hereford, Angus, Brahma, Devon, and Holstein bulls for their first calf crop; to Hereford, Angus, Gelbvieh, Maine Anjou, and Chianina bulls for their second calf crop; and to Brown Swiss bulls for subsequent calf crops.
b Includes calves requiring calf puller or C-section.
c Adjusted to a steer basis.
d Average of three 12-hour milk production measures on a sample of 18 cows per breed group at 3 and 4 years of age.
e Cow weight taken in fall at weaning time when cows were 7-year-olds.

TABLE 3. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
BREED GROUP MEANS FOR REPRODUCTION AND MATERNAL PERFORMANCE OF CROSSBRED COWS AT 2 THROUGH 5 YEARS OF AGE
CYCLE I-PHASE 3 - COWS BORN 1972-73-74a

Calving					200-day weight						
Breed of cow		Number births	diffi- culty ^c %	Calf crop		Birth weight ^d lb	Cow weight ^e lb	Per calf weaned ^d lb	Ratio ^f %	Per cow exposed lb	Ratio ^f %
Sire	Dair ^b			Born %	Weaned %						
Angus Hereford	Hereford-X	116	15	94	81	80	1002	432	101	350	96
	Angus-X	127	26	93	89	80	972	423	99	376	104
	Average	243	20	94	85	80	987	427	100	363	100
Brahman	Hereford-X	72	4	87	79	75	1029	474	111	374	103
	Angus-X	51	6	96	89	76	1069	484	113	431	119
	Average	123	5	92	84	76	1049	479	112	402	111
Devon	Hereford-X	89	14	92	85	81	989	428	100	364	100
	Angus-X	83	18	93	83	79	995	422	99	350	96
	Average	172	16	93	84	80	992	425	100	357	98
Holstein	Hereford-X	64	12	97	87	86	1049	492	115	428	118
	Angus-X	49	20	100	87	87	1047	487	114	424	117
	Average	113	16	98	87	86	1048	490	115	426	117
Average all sire breeds	Hereford-X	341	11	93	83	80	1017	456	107	378	104
	Angus-X	310	17	96	87	80	1021	454	106	395	109
	Average	651	14	94	85	80	1019	455	107	387	107

^a These cows were bred to Red Poll bulls for all calf crops.

^b Hereford-X denotes Hereford crosses and Angus-X denotes Angus crosses. Dams of these cows were sired by Hereford, Angus, Jersey, South Devon, Limousin, Simmental, and Charolais bulls.

c. Includes calves requiring calf puller or C-section.

d Adjusted to a steer basis.

e Cow weight taken in fall at weaning time when cows were 3-year-olds.

f Ratio computed relative to average for Hereford and Angus sired dams.

TABLE 4. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
BREED GROUP MEANS FOR REPRODUCTION AND MATERNAL PERFORMANCE OF F₁ COWS AT 2 THROUGH 7 YEARS OF AGE
CYCLE II-PHASE 2 - COWS BORN 1973-74^a

Sire	Breed of cow		Number births	Calving diffi- culty ^b		Calf crop		Birth weight ^c lb	Milk prodd lb	Cow weight ^e lb	Per calf weaned ^c		200-day weight		Ratio ^f %
	Dam			%	%	Born	Weaned				lb	lb	Ratio ^f %	Per cow exposed lb	
Angus Hereford	Hereford Angus Average	Hereford Angus Average	185	12	91	85	87	1273			482	410	100	101	
			253	20	91	84	89		1200	482	405	100	100		
			438	16	91	84	88	6.2	1236	481	404	100	100		
Red Poll	Hereford Angus Average	Hereford Angus Average	205	20	91	81	93	1187			511	414	106	102	
			256	14	88	78	88		1179	504	393	105	97		
			461	17	90	79	91	7.6	1183	508	401	106	99		
Brown Swiss	Hereford Angus Average	Hereford Angus Average	349	13	92	83	95	1265			540	448	112	111	
			332	9	93	86	92		1243	541	465	112	115		
			681	11	92	85	93	8.4	1254	540	459	112	114		
Gelbvieh	Hereford Angus Average	Hereford Angus Average	207	15	96	88	94	1313			539	474	112	117	
			222	13	94	86	90		1280	539	464	112	115		
			429	14	95	87	92	8.4	1297	539	469	112	116		
Maine Anjou	Hereford Angus Average	Hereford Angus Average	209	15	93	86	99	1389			534	459	111	114	
			259	14	94	86	96		1365	522	449	109	111		
			468	14	94	86	98	6.5	1377	528	454	110	112		
Chianina	Hereford Angus Average	Hereford Angus Average	233	10	93	87	98	1392			529	460	110	114	
			242	11	92	85	96		1370	529	450	110	111		
			475	11	93	86	97	6.2	1381	529	455	110	113		
Average all sire breeds	Hereford Angus Average	Hereford Angus Average	1388	14	93	85	94	1303			522	444	109	110	
			1564	14	92	84	92		1273	519	436	108	108		
			2952	14	92	85	93	7.2	1288	217	443	108	110		

^a These cows were bred to Hereford, Angus, Brangus, and Santa Gertrudis bulls for their first calf crop and to 3/4 or 7/8 Simmental bulls for subsequent calf crops.

^b Includes calves requiring calf puller or C-section.

^c Adjusted to a steer basis.

^d Average of three 12-hour milk production measures on a sample of 18 cows per breed group at 3 years of age.

^e Cow weight taken in fall at weaning time when cows were 7-year-olds.

^f Ratio computed relative to average for Hereford-Angus reciprocal cross dams.

TABLE 5. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
BREED GROUP MEANS FOR REPRODUCTION AND MATERNAL PERFORMANCE OF CROSSED COWS AT 2 THROUGH 5 YEARS OF AGE
CYCLE II-PHASE 3 - COWS BORN 1975-76^a

Sire	Breed of cow	Dam ^b	Calving		Calf crop		Birth weight ^d lb	Cow weight ^e lb	200-day weight	
			Number births	difficult ^c %	Born	Weaned			Per calf weaned ^f lb	Ratio ^f %
Angus Hereford		Hereford-X	101	16	92	79	83	1103	488	100
		Angus-X	116	22	87	80	84	1073	486	100
		Average	217	19	90	80	84	1088	487	100
Brangus		Hereford-X	91	17	87	82	86	1083	507	104
		Angus-X	70	19	88	77	87	1087	513	105
		Average	161	18	87	80	86	1085	510	105
Santa Gertrudis		Hereford-X	58	11	88	75	85	1117	513	105
		Angus-X	53	7	88	70	86	1120	521	107
		Average	111	9	87	72	86	1119	517	106
Average all sire breeds		Hereford-X	111	15	89	79	84	1101	503	103
		Angus-X	239	14	88	76	86	1093	506	104
		Average	489	14	88	77	85	1097	505	104

- ^a These cows were bred to Shorthorn bulls for their first calf crop and to Simmental bulls for subsequent calves.
^b Hereford-X denotes Hereford crosses and Angus-X denotes Angus crosses. Dams of these cows were sired by Hereford, Angus, Red Poll, Brown Swiss, Gelbvieh, Maine Anjou, and Chianina bulls.
^c Includes calves requiring calf puller or C-section.
^d Adjusted to a steer basis.
^e Cow weight taken in fall at weaning time when cows were 3-year-olds.
^f Ratio computed relative to average for Hereford and Angus sired dams.

TABLE 6. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM
BREED GROUP MEANS FOR REPRODUCTION AND MATERNAL PERFORMANCE OF F₁ COWS AT 2 THROUGH 7 YEARS OF AGE
CYCLE III-PHASE 2 - COWS BORN 1975-76^a

Sire	Breed of cow	Dam	Calving			Birth weight ^c lb	Milk prod ^d lb	Cow weight ^e lb	200-day weight		
			Number births	diffi- culty ^b %	Calf crop Born % Weaned %				Per calf weaned ^c lb	Ratio ^f %	Per cow exposed lb
Angus Hereford		Hereford	154	10	89	84		1219	480	102	403
		Angus	355	17	90	83		1205	463	98	384
		Average	509	14	90	83	5.4	1212	471	100	391
Pinzgauer		Hereford	204	16	92	82		1209	508	108	417
		Angus	304	12	91	85		1205	502	107	427
		Average	508	14	92	84	7.3	1207	505	107	424
Tarentaise		Hereford	147	12	91	85		1227	528	112	449
		Angus	222	9	88	83		1159	511	108	424
		Average	369	11	90	84	7.2	1193	520	110	437
Brahman		Hereford	210	2	93	83		1295	535	114	444
		Angus	309	2	94	88		1250	534	113	470
		Average	519	2	93	85	8.4	1272	535	114	455
Sahiwal		Hereford	160	4	95	89		1133	504	107	449
		Angus	271	2	94	87		1080	493	105	429
		Average	431	3	94	88	7.8	1107	498	106	438
Average all sire breeds		Hereford	875	9	92	85		1217	511	108	434
		Angus	1461	9	92	85		1180	501	106	426
		Average	2336	9	92	85	7.2	1198	506	107	430

^a These cows were bred to Red Poll bulls for their first calf crop and to 7/8 Simmental bulls for subsequent calf crops.

^b Includes calves requiring calf puller or C-section.

^c Adjusted to a steer basis.

^d Average of three 12-hour milk production measures on a sample of 18 cows per breed group at 3 years of age.

^e Cow weight taken in fall at weaning time when cows were 6-year-olds.

^f Ratio computed relative to average for Hereford-Angus reciprocal cross dams.

APPENDIX

TABLE 1. MATING PLANS TO PRODUCE CYCLE I-PHASE 2 CALVES

1969, 1970, 1971 Breeding Seasons

Dam breeds ^a	Sire Breeds						Charo-lais
	Here-ford	Angus	Jersey	South Devon	Limou-sin	Sim-mental	
Hereford	X	X	X	X	X	X	X
Angus	X	X	X	X	X	X	X

^a The cows were 1, 2, 3, and 4-year-olds in 1969; 1, 2, 3, 4, and 5-year-olds in 1970; and 2, 3, 4, 5, and 6-year-olds in 1971.

APPENDIX

TABLE 2. MATING PLANS TO PRODUCE CYCLE II-PHASE 2 CALVES

1972 and 1973 Breeding Seasons

Dam breeds ^a	Sire breeds						Chia-nina
	Here-ford ^b	Angus ^b	Red Poll	Brown Swiss	Gelb-vieh	Maine Anjou	
Hereford ^c	X	X	X	X	X	X	X
Angus ^c	X	X	X	X	X	X	X
Red Poll	X	X	X	X			
Brown Swiss	X	X	X	X			

^a The cows were 3-, 4-, 5-, 6-, and 7-year-olds in 1972; and 3-, 4-, 5-, 6-, 7-, and 8-year-olds in 1973.

^b Sample of same Hereford and Angus sires used in Cycle I, 1969-71 breeding seasons.

^c Cows used for GPE Cycle I, 1969-71 breeding seasons.

APPENDIX

TABLE 3. MATING PLANS TO PRODUCE CYCLE I-PHASE 3 CALVES^a

1971 - 1978 Breeding Seasons

	Sire Breeds										Subsequent calf crops ^d
	First calf crop ^b					Second calf crop ^c					
Breed Group	Here- ford ^e	Angus ^e	Brahman	Devon	Hol- stein	Here- ford ^e	Angus ^e	Gelb- vieh	Maine Anjou	Chia- nina	Brown Swiss
H x H		X									X
A x A	X					X					X
A x H			X	X	X			X	X	X	X
H x A			X	X	X			X	X	X	X
J x H		X	X	X	X		X	X	X	X	X
J x A	X		X	X	X	X		X	X	X	X
SD x H		X	X	X	X		X	X	X	X	X
SD x A	X		X	X	X	X		X	X	X	X
L x H		X	X	X	X		X	X	X	X	X
L x A	X		X	X	X	X		X	X	X	X
S x H		X	X	X	X		X	X	X	X	X
S x A	X		X	X	X	X		X	X	X	X
C x H		X	X	X	X		X	X	X	X	X
C x A	X		X	X	X	X		X	X	X	X

^a Females of each breed group distributed equally among cells marked "X" for each calf crop.

^b Each group of heifers bred as yearlings to produce one calf crop as 2-year-olds by these breeds in 1972-74.

^c Each group of cows bred as 2-year-olds to produce one calf crop as 3-year-olds by these breeds in 1973-75.

^d Each group of cows bred to produce at least four calf crops by this breed from 1974 through 1979.

^e Sample of same sires used in Cycle I, 1969-71 breeding seasons.

APPENDIX

TABLE 4. MATING PLANS TO PRODUCE CYCLE II-PHASE 3 CALVES^a

1974-1981 Breeding Season

Female breeding groups	First calf crop ^b				Subsequent calf crops ^c
	Hereford ^d	Angus ^d	Brangus	Santa Gertrudis	Simmental
Hereford		X	X	X	X
Angus	X		X	X	X
Red Poll	X	X			X
Brown Swiss	X	X			X
H x A & Recip.			X	X	X
H x R.P. & Recip.		X	X	X	X
H x B.S. & Recip.		X	X	X	X
A x R.P. & Recip.	X		X	X	X
A x B.S. & Recip.	X		X	X	X
Gelbvieh x Hereford			X	X	X
Gelbvieh x Angus	X		X	X	X
Maine Anjou x Hereford		X	X	X	X
Maine Anjou x Angus	X		X	X	X
Chianina x Hereford		X	X	X	X
Chianina x Angus	X		X	X	X

^a Females of each breed group distributed equally among the cells marked "X" for each calf crop.

^b Each group of heifers bred as yearlings to produce one calf crop as 2-year-olds by these breeds in 1975 and 1976.

^c Each group of cows mated to produce at least three calf crops by 3/4 or 7/8 Simmental bulls in 1976 through 1982.

^d Sample of same Hereford and Angus sires used in Cycle I-Phase, 1969-71 breeding seasons.

APPENDIX

TABLE 5. MATING PLANS TO PRODUCE CYCLE III-PHASE 2 CALVES^a

1974 and 1975 Breeding Seasons

Dam breeds ^b	Sire breeds					
	Hereford ^c	Angus ^c	Pinzgauer	Tarentaise	Brahman	Sahiwal
Hereford		X	X	X	X	X
Angus	X		X	X	X	X

^a Approximately 256 heifers (32 of each breed group, except Tarentaise) were transferred to Brooksville, Fla.

^b Cows used for GPE Cycle I, 1969, 1970 and 1971 and Cycle II, 1972 and 1973 breeding seasons.

^c Sample of same Hereford and Angus sires used to produce Cycle II-Phase 2 and Cycle II-Phase 2 calves.

APPENDIX

TABLE 6. MATING PLANS TO PRODUCE CYCLE II-PHASE 3 CALVES^a

1976-1981 Breeding Seasons

Breed group	Sire breeds	
	First Calf Crop ^b	Subsequent Calf Crops ^c
	Red Poll	Simmental
A x H	X	X
H x A	X	X
P x H	X	X
P x A	X	X
T x H	X	X
T x A	X	X
Br x H	X	X
Br x A	X	X
Sw x H	X	X
Sw x A	X	X

^a Females of each breed group distributed equally among cells marked "X" for each calf crop.

^b Each group of heifers bred as yearlings to produce one calf crop as 2-year-olds by Red Poll bulls in 1977 and 1978.

^c Each group of cows bred to produce at least four calf crops by Simmental bulls from 1978 through 1982.

U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
NORTH CENTRAL REGION
Mid-Great Plains Area
Roman L. Hruska U.S. Meat Animal
Research Center
P.O. Box 166
Clay Center, Nebraska 68933

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PRELIMINARY RESULTS FROM CYCLE IV OF THE GERM PLASM EVALUATION PROGRAM
AT THE ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER

Larry V. Cundiff, Robert M. Koch, Keith E. Gregory,
John D. Crouse and Michael E. Dikeman

Agricultural Research Service, U.S. Department of Agriculture
Clay Center, NE 68933
University of Nebraska and
Kansas State University

Breed differences in performance characteristics are an important genetic resource for improving efficiency of beef production. Diverse breeds are required to exploit heterosis and complementarity through crossbreeding and to match genetic potential with diverse markets, feed resources and climates. This report presents preliminary results from an ongoing study at the Roman L. Hruska U.S. Meat Animal Research Center to characterize breeds of cattle representing different biological types for traits that influence quantity and value of production.

Experimental Procedure

The Germ Plasm Evaluation (GPE) program has been conducted in four cycles. Table 1 shows the mating plan for cycles I, II, III, and IV. Each cycle was initiated by mating Hereford and Angus cows by artificial insemination (AI) to sires of diverse breeds. Semen from the same Hereford and Angus bulls has been used throughout to produce control Hereford-Angus (original HAX, sires born 1968-70) reciprocal crosses in each cycle. In cycle IV, new samples of Hereford and Angus (current HAX, sires born 1982-84) bulls were added to evaluate genetic trends within these breeds. In cycle IV, semen from 14 original control Angus, 11 original control Hereford, 30 current Angus, 32 current Hereford (14 horned and 18 polled), 29 Longhorn, 24 Piedmontese, 31 Charolais, 29 Salers, 31 Galloway, 22 Nellore, and 26 Shorthorn bulls is being used by AI to produce about 200 calves per sire breed in five calf crops (1986-1990). Following an AI period of about 45 days, one or two bulls each of Angus, Hereford, Charolais, Gelbvieh, and Pinzgauer bulls are used each year by natural service in single-sire breeding pastures for about 21 days. These breeds are being used in clean-up matings to increase ties to previous cycles and facilitate eventual pooling of results over all four cycles.

Calving occurs in the spring, beginning in late March and ending in mid-May. Calves are weighed, tattooed, and tagged for identification. Male calves are castrated within 24 hours of birth. Calves are creep fed whole oats from mid-July until weaning in early October.

Following a postweaning adjustment period of about 35 days, steers are penned and fed separately by sire breed for about 200 to 263 days. Growing diets contain 66% corn silage, 22% corn, 12% supplement and the finishing diet fed from about 700 lb to slaughter contains 25% corn silage, 70% corn, 5% supplement. Representative samples of steers are slaughtered serially in 4 slaughter groups spanning at least 63 days. The steers are slaughtered in a commercial packing plant, and hot carcass weights are obtained and used to estimate dressing percent ($100 \times \text{carcass weight} / \text{final live weight}$). After a 24-hour chill, USDA yield grade (fat thickness, longissimus area, estimated % kidney fat) and quality grade (marbling, maturity) data are obtained. The right side of the carcass is transferred to the meat laboratory at MARC and

fabricated into boneless, retail cuts trimmed to 8 mm fat thickness. Retail cuts are then trimmed free of fat (0 mm) and reweighed. Retail product (including all steaks, roasts and lean trim (trimmed to 25% fat basis)) from the right side is doubled to estimate retail product yield from the carcass in terms of weight and as a percentage of cold carcass weight. Warner-Bratzler shear determinations of tenderness are taken on cooked rib steaks from each carcass following AMSA procedures.

All F1 females produced are retained to evaluate growth, age at puberty, reproduction and maternal performance through mature ages. Heifers are carried in a drylot from weaning to about 400 days of age on a diet containing 54% corn silage, 42% haylage, 4% supplement until January and 45% corn silage, 54% haylage and 1.1% supplement until they are moved to grass in the spring. Estrus was checked visually twice daily from an average age of about 250 days until the end of the breeding season at about 450 days of age. Date at puberty was defined as date at first observed estrus confirmed by a subsequent estrus observed within 45 days. Females are bred by natural service to Red Poll sires to produce their first calves as 2-year-olds and subsequently to Simmental sires through mature ages. Preweaning management is the same as that described above for F1 crosses, except that progeny of F1 dams are not creep fed.

TABLE 1. SIRE BREEDS USED IN GERM PLASM EVALUATION PROGRAM

Cycle I (1970-72)	Cycle II (1973-74)	Cycle III (1975-76)	Cycle IV (1986-90)
----------------------	-----------------------	------------------------	-----------------------

F1 crosses from Hereford or Angus dams (Phase 2)

Hereford	Hereford	Hereford	Hereford ^a
Angus	Angus	Angus	Angus ^a
Jersey	Red Poll	Brahman	Longhorn
South Devon	Brown Swiss	Sahiwal	Salers
Limousin	Gelbvieh	Pinzgauer	Galloway
Simmental	Maine Anjou	Tarentaise	Nellore
Charolais	Chianina		Shorthorn
			Piedmontese
			Charolais
			Gelbvieh
			Pinzgauer

3-way crosses out of F1 dams (Phase 3)

Hereford	Hereford
Angus	Angus
Brahman	Brangus
Devon	Santa Gertrudis
Holstein	

^aHereford and Angus sires, originally sampled in 1969, 1970 and 1971, have been used throughout the program. In Cycle IV, a new sample of Hereford and Angus sires produced after 1982 are being used and compared to the original Hereford and Angus sires.

Preliminary Results

Breed group means averaged over Hereford and Angus dams are shown in Table 2 for calving difficulty, birth weight, calf survival, and 200-day weight. These results are preliminary, including the first four of five calf crops to be produced in cycle IV. F1 progeny by current Hereford and Angus sires were heavier at birth (5.5 lb) and weaning (18 lb) than F1 progeny by original Hereford and Angus sires, indicating that significant genetic change for growth rate accrued in these breeds between the late 1960's and the early 1980's in response to selection emphasis that seedstock breeders for both of these breeds. It might be surprising to readers that the increase in birth weight for progeny of current versus original sires was associated with only a slight increase in calving difficulty; however, the Hereford and Angus cows producing these calves were 3 through 10 years of age. Calving difficulty is not expected to be a serious problem in cows these ages.

Relative to original Hereford-Angus crosses, the results for birth weight and 200-day weaning weight of Charolais and Gelbvieh were consistent with those observed in previous cycles. Weaning weights of Longhorns were the lightest. Galloway were similar to Hereford-Angus crosses by original sires in weaning weight. Weaning weights of Shorthorn and Salers crosses were similar to Pinzgauer and intermediate to current Hereford-Angus crosses and the heaviest breed groups, Nellore and Charolais.

Breed group means for final weight and certain carcass and meat characteristics are shown in Table 3 for steers from the first three of five calf crops to be produced. Differences among breeds for final weight correspond relatively closely to those for weaning weight, except that Nellore crosses were relatively lighter after the postweaning period which included the winter months. Progeny of current Hereford and Angus sires were significantly heavier than progeny of original sires; however, carcass composition and marbling was similar. Breed groups that excelled in marbling and percentage grading choice (Shorthorn, Angus-Hereford crosses) had the lowest percentage retail product. Breeds that have the highest yields of retail product (Piedmontese, Charolais, Gelbvieh, Salers and Nellore) had the lowest percentage grading choice.

Carcasses from Galloway and Longhorn crosses had higher percentage retail product, but were lighter in weight and had fewer grading Choice than Hereford-Angus crosses. Piedmontese crosses excelled in carcass composition. Although Piedmontese crosses ranked eighth (comparable to original Hereford-Angus crosses) among the 11 breed groups in final weight, they ranked second in weight of totally trimmed (0 mm) retail product due to exceptional dressing percentage and significantly higher retail product percentages than other breeds. Salers crosses were intermediate in growth rate to weaning and yearling ages. Marbling was low but retail product yield as a percentage of carcass weight was relatively high in Salers crosses. Salers, Pinzgauer, Gelbvieh and Nellore crosses were comparable in lean growth potential as reflected in weight of retail product at 417 days of age.

Breeds ranked very differently for marbling than they did for tenderness. Shorthorn crosses and Hereford-Angus crosses excelled in marbling but shear and sensory panel estimates of tenderness were comparable to those of other Bos taurus sired breed groups with lower levels of marbling. Percentage grading

TABLE 2. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM, CYCLE IV-PHASE 2 CALVES BORN 1986-89

Breed group of calf	No. calves		Calvings unassisted %	Birth weight lb	Calf surv. %	200-day weight	
	Born	Wean.				Units lb	Ratio %
Original HAx	167	163	95.3	79.3	96.3	463	96.1
Current HAx	197	181	96.4	85.9	91.6	481	100.0
Charolais	172	155	90.8	90.2	89.9	508	105.5
Gelbvieh	203	191	98.1	89.3	94.0	504	104.8
Pinzgauer	208	197	95.0	89.5	95.0	499	103.7
Shorthorn	134	125	99.6	87.4	93.2	492	102.2
Galloway	147	139	98.2	81.0	94.3	459	95.5
Longhorn	171	158	99.7	71.3	92.8	441	91.6
Nellore	172	160	94.3	89.6	93.0	507	105.4
Piedmontese	174	163	93.7	84.9	93.6	483	100.3
Salers	160	150	97.8	85.4	93.9	495	102.8

TABLE 3. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION PROGRAM, CYCLE IV-PHASE 2 STEERS BORN 1986-88^a

Breed group of steer	No.	Final wt lb	Dress. pct. %	USDA Choice %	WB shear lb	Fat thick- ness in	Rib eye area sq in	Retail product			
								.3 in trim %	.0 in trim %	.3 in trim lb	.0 in trim lb
Orig. HAx	46	1079	62.2	79	11.7	.58	10.90	69.1	63.3	443	406
Cur. HAx	58	1145	62.1	74	12.5	.55	10.88	69.3	63.6	474	434
Charolais	55	1218	62.0	51	12.8	.38	12.27	71.9	66.7	553	484
Gelbvieh	87	1175	62.2	45	12.3	.36	12.10	72.2	67.0	507	469
Pinzgauer	70	1155	61.1	59	11.2	.42	11.29	70.6	65.3	481	444
Shorthorn	53	1172	62.0	89	12.4	.49	11.06	69.0	63.5	483	443
Galloway	46	1045	62.5	63	12.4	.44	11.12	71.8	66.2	450	414
Longhorn	56	976	61.7	62	12.6	.36	10.59	71.6	66.2	415	383
Nellore	61	1121	64.9	47	15.4	.49	11.51	71.3	65.8	499	460
Piedmontese	53	1091	63.9	41	11.0	.29	13.19	75.5	70.9	505	474
Salers	50	1155	62.6	47	13.2	.40	11.79	71.9	66.5	496	459

^aMeans for weight and carcass traits at average slaughter age of 417 days.

Choice was low but steaks were relatively tender in Piedmontese crosses. Marbling was also low in Nellore crosses and their shear values were distinctly higher than all other crosses. Steaks from Nellore crosses, like *Bos indicus* breeds evaluated earlier (Brahman and Sahiwal), were less tender than those from *Bos taurus* sire breeds.

Breed group means for 400-day weights, 550-day weights, puberty characteristics and conception rate of heifers are shown in Table 4. Means for calf crop percentage, calving ease, birth and weaning weights of progeny are shown in Table 5. Again, it is emphasized that these results are preliminary, including females from only the first two of five calf crops to be produced in cycle IV. Means for traits such conception rate, percentage calf crop born and weaned, and percentage calvings unassisted have large experimental errors due to their all or none (calf or no calf) nature and the limited number of matings to date (e.g., one calf affects each breed group mean about 1.5 to 2%).

Breed group differences for 400- and 550-day weights in heifers correspond closely to those for final weight in steers. Nellore crosses like Brahman and Sahiwal breeds evaluated earlier, were relatively older at puberty, but excelled in calving ease due to maternal effects reducing birth weight. Birth weights of progeny and calving assistance were relatively low for Longhorn F1 females. Considering the heavy birth weights of progeny, calving assistance tended to be relatively low for Salers and Shorthorn females. Birth weights of progeny of Hereford-Angus cross females by current sires were heavier than those by original sires but calving assistance was similar. Progeny out of Salers, Nellore, Shorthorn, Pinzgauer, and Gelbvieh sired F1 females were heavier at weaning than those out of Piedmontese and current Hereford-Angus crosses which were in turn heavier than those out of original Hereford-Angus crosses or Longhorn and Galloway sired F1 females.

TABLE 4. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION
PROGRAM, CYCLE IV-PHASE 2 HEIFERS BORN 1986-87

Breed group of female	No.	400-day weight lb	550-day weight lb	Puberty expressed %	Age at puberty ^a		Preg. rate %
					Act. d	Adj. d	
Original HAx	46	723	840	95	370	373	95
Current HAx	48	766	890	97	365	368	87
Charolais	38	781	923	91	361	367	83
Gelbvieh	58	755	890	98	357	359	83
Pinzgauer	59	779	915	100	357	357	92
Shorthorn	32	778	909	95	363	367	84
Galloway	40	690	807	94	368	373	81
Longhorn	44	661	794	95	375	378	86
Nellore	42	746	891	94	402	407	92
Piedmontese	48	726	862	98	354	355	95
Salers	38	779	917	98	366	368	90

^aActual age at puberty for the heifers expressing puberty (ranging from 91 to 100 percent) and adjusted age at puberty, adjusted to remove bias due to differences in percentage expressing puberty by adding i(s) where i is the expected negative deviation from the true mean in standard deviation (s) units.

TABLE 5. ROMAN L. HRUSKA U.S. MEAT ANIMAL RESEARCH CENTER GERM PLASM EVALUATION
PROGRAM, CYCLE IV-PHASE 3 CALVES BORN 1988-89^a

Breed group of dam	No. cows exp.	Calf crop		Calvings unassisted %	Birth weight lb	200-day weight	
		Born %	Wean. %			Units lb	Ratio %
Original HAx	74	89	83	67.6	75.6	458.3	94.0
Current HAx	78	92	89	68.9	80.2	487.5	100.0
Charolais	60	81	76	72.9	83.0	498.7	102.3
Gelbvieh	68	82	79	70.7	78.7	507.7	104.1
Pinzgauer	72	85	81	64.0	82.4	508.1	104.2
Shorthorn	43	90	85	75.2	84.0	512.6	105.1
Galloway	67	83	80	74.9	74.1	449.2	92.1
Longhorn	70	92	89	86.0	74.9	464.2	95.2
Nellore	69	94	93	95.1	70.7	513.5	105.3
Piedmontese	78	90	88	64.6	79.2	491.9	100.9
Salers	58	88	85	85.7	82.5	523.9	107.4

^aData are for 560 F1 females exposed to Red Poll bulls to produce first calves at 2 years of age and for 312 F1 females exposed to Simmental bulls to produce their second calves at 3 years of age.